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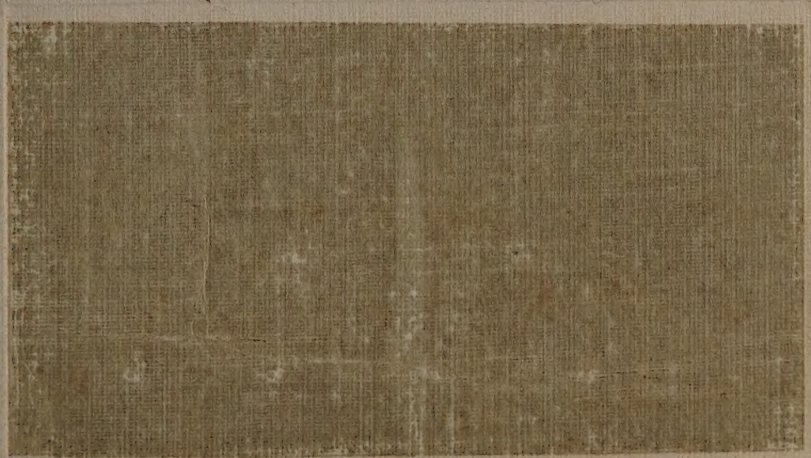

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HANDBOOK

for

D.C. AMPLIFIER

Types M.1266, M.1266A and M.1266B

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Note: M.1266 is the Southern Instruments Limited code number for the amplifier type FE-151-BD designed and manufactured by:- Fylde Electronic Laboratories Ltd.

20266 Printed in England.

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	GALVANOMETER MATCHING NETWORKS	M.1854A/1 M.1300/341

1 INTRODUCTION

The D.C. Amplifier type M.1266 is a general purpose differential amplifier intended for us in low level data handling and as a pre-amplifier for galvanometer or other direct writing recorders.

The amplifier has wide band capability and low noise and achieves low drift performance by virtue of a monolithic transistor pair input stage.

The M.1266 differential D.C. Amplifier has a high common-mode rejection figure together with a high input resistance both to in-phase and differential signal sources and requires no guard shield when connected to a floating source. The output is truly single-ended and feedback gain control is achieved by a novel orthogonal differential stage.

Silicon transistors are used throughout with overload protection combining to ensure that a high order of reliability is maintained.

The amplifier is constructed using printed circuit techniques and is available as a complete functional unit with front panel control of gain and D.C. shift or as a printed circuit card with connector and trim potentiometer controls.

2 TECHNICAL DATA

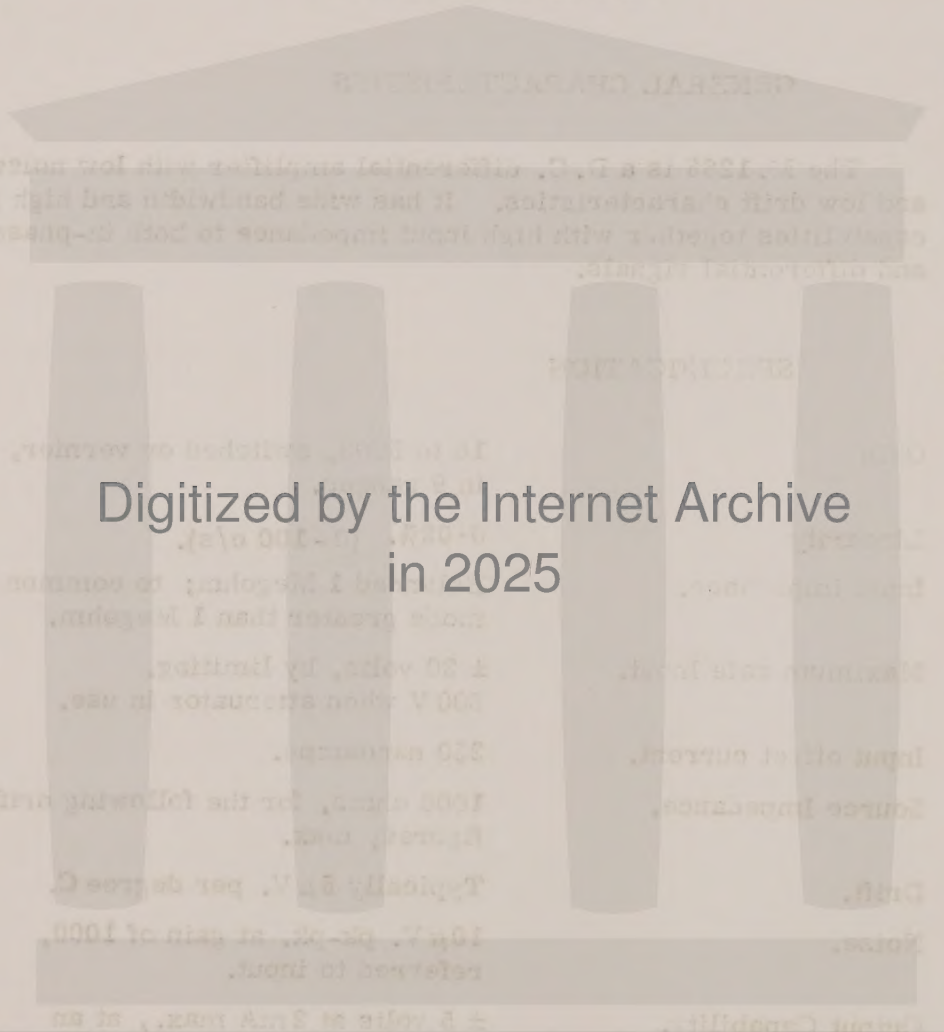
2.1 GENERAL CHARACTERISTICS

The M.1266 is a D.C. differential amplifier with low noise and low drift characteristics. It has wide bandwidth and high gain capabilities together with high input impedance to both in-phase and differential signals.

2.2 SPECIFICATION

Gain	10 to 5000, switched or vernier, in 9 ranges.
Linearity	0·02%. (0 - 100 c/s).
Input Impedance.	Balanced 1 Megohm; to common mode greater than 1 Megohm.
Maximum safe Input.	± 20 volts, by limiting. 500 V when attenuator in use.
Input offset current.	250 nanoamps.
Source Impedance.	1000 ohms, for the following drift figures, max.
Drift.	Typically 5 μV. per degree C.
Noise.	10 μV. pk-pk. at gain of 1000, referred to input.
Output Capability. (0 - 10 Kc/s).	± 5 volts at 2 mA max., at an output impedance of 1 ohm typical and (M1266 only) ± 50 mA at high output impedance. *
Common-mode rejection.	Typically 100 dB. (attenuator at x 1 . and gain x 1000).
Common mode voltage.	6 volts maximum.
Offset control.	± 5 volts at output.

* M.1266A ± 100 mA.



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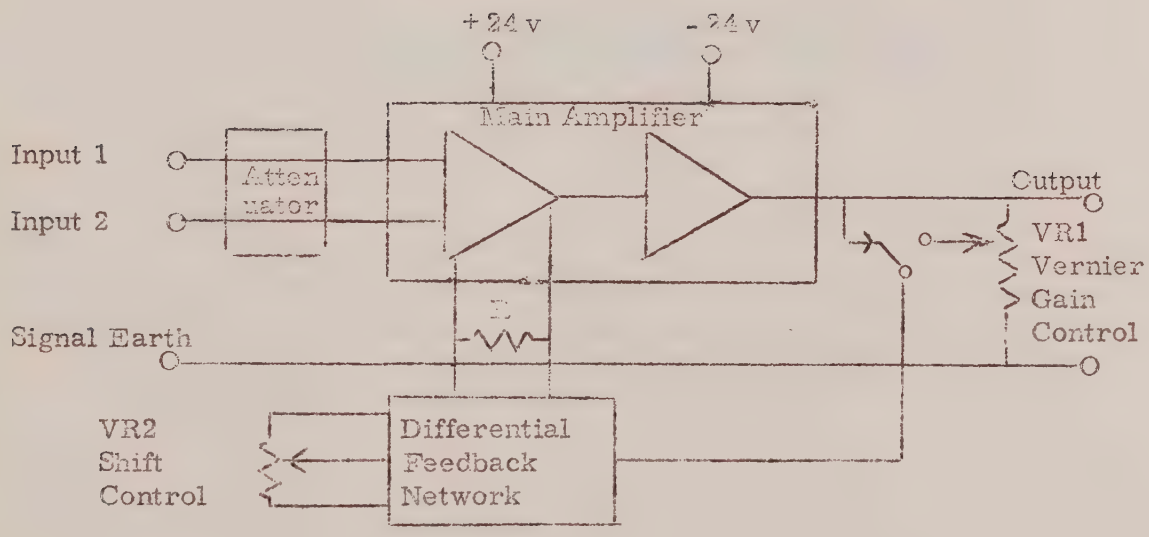
Bandwidth (small signal).	100 Kc/s at gain of 100, may be switched if required.
Temperature range:	-20 degree C. to +85 degree C. This does not apply to the additional 50 mA o/p stage.
Power requirements:	+24 V and -24 V supplies. Maximum current from each line is 80 mA (M.1266), 112 mA (M.1266A) or 10 mA (M.1266B).
Overall dimensions:	Height 3" Width 2" Depth 9 1/2" Weight 1 lb. 5 oz.

3 CIRCUIT DESCRIPTION



3.1 GENERAL

The amplifier is considered in three sections: the main D.C. amplifier, the auxiliary differential feedback network and the balanced attenuator which precedes the main amplifier.

3.2 THE D.C. AMPLIFIER

The first stage of the amplifier has in-built drift correction through the use of the solid circuit differential pair and a high gain and low drift is inherent in this first stage. The stage is run at low current to give low noise and high input impedance.

The second differential stage of this main amplifier converts the signal to a single-ended drive for the three-stage output circuit.

This output has a common emitter amplifying stage driven by a compensating emitter follower and itself drives an emitter follower output transistor employing a Zener diode as level shifting device. The amplifier has a high gain-bandwidth figure and excellent gain linearity.

3.3 THE DIFFERENTIAL FEEDBACK NETWORK

In order to achieve defined gain, overall feedback is employed via a differential transistor network, which gives precise gain definition with negligible deterioration of the common-mode rejection figure.

Switched gain is accomplished by variation of resistor R and vernier adjustment of gain by the potentiometer VR1. VR2 is a potentiometer across a compensated Zener chain which gives shift via the differential feedback network.

3.4 THE ATTENUATOR

A balanced attenuator is incorporated in the amplifier, which extends the application of the amplifier up to inputs of 500 volts maximum. When the attenuator is in use, the common mode rejection of the amplifier is somewhat reduced.

4 OPERATION OF AMPLIFIER

4.1 CONNECTIONS

The connections to the unit are shown on the circuit diagram (M.1266/1). The 3-pin input plug allows connection of the two signal input leads and the earth return for the input lead screen (note that this screen should not be connected to the outer shell of the input, to avoid earth current problems). The output and power supply connections are made at the rear of the unit.

Signals from an unbalanced (i.e. single-ended) source may be applied to either of the two amplifier inputs, the input not in use being connected to signal earth.

Signals from a balanced source of course require the use of both amplifier inputs. It must be remembered that the limits of 'common mode' signals (i.e. the maximum level with respect to the earth return) is ± 6 V.

If in certain applications a signal earth return cannot be provided, e.g. during the open period of a multiplex sequence, the amplifier input may be allowed to float provided that the resistance between the two inputs remains finite; the amplifier output will then remain near the working zero.

Note that the maximum allowable source resistance is 1 kohm end to end at the amplifier input, unless the attenuator is in use, when this restriction does not apply.

4.2 VOLTAGE OUTPUT

The M.1266, M.1266A and M.1266B amplifiers provide a voltage of ±5 V about earth, at a maximum current of ±2 mA. The output impedance of the amplifier is low, and it will be necessary to insert a matching network in the output lead if the load is an electrically damped galvanometer (see Drg. No. M.1300/341). The output lines can tolerate up to 0·05 μF capacitance across them.

4.3 CURRENT OUTPUT

The M.1266 amplifier also provides a high current output, normally restricted to ± 50 mA, ± 100 mA (M.1266A). To bring this into use, link the voltage amplifier output to the current amplifier input on the rear of the amplifier, and connect the galvanometer or other low resistance load to the current output pins. (Note: care must be taken that only one galvanometer is connected to each amplifier and that galvanometer leads are not commoned or taken to earth. This is because the gain of the high current amplifier is fixed by the 100 ohm feedback resistor, through which the galvanometer current flows to the common supply lead).

The output stage is designed to limit at ± 50 mA (35 Ω load); this value may be increased by reducing the value of the 160 ohm resistors in the emitter leads of the output transistors.

4.4 GAIN SETTING

As already stated, the maximum output swing from the amplifier is 10 V (± 5 V), 200 mA (± 100 mA) M.1266A only, or 100 mA (± 50 mA). The input required to produce full output at various gain settings are thus as follows:-

Gain Setting	Input for full output
10	1 V peak to peak
20	500 mV "
50	200 mV "
100	100 mV "
200	50 mV "
500	20 mV "
1000	10 mV "
2000	5 mV "
5000	2 mV "

4.5 SETTING ZERO

When adjusting the amplifier zero, the inputs should be short-circuited together and connected to earth. With the gain control in the required position, the output should be brought to earth potential using the zero control.

(Note that the 'Zero' switch short-circuits the two inputs together when switched to the 'Set' position, and may thus be used for setting the zero. However, when operating single ended with the second input earthed, switching to 'Set' short-circuits the input signal; if this is undesirable, the input plug should be withdrawn).

On re-connecting the amplifier to the signal source the output voltage may shift because of the offset input current flowing through the source resistance. This shift may be cancelled by re-adjusting the zero control.

4.6 SPECIAL PRECAUTIONS

4.6.1 Input Circuit

Input return must always be present through to the power supply common and this is usually present via earth paths common to both connections. If a direct connection is not acceptable then at least 1 Megohm shunt path must be provided.

4.6.2 Long Input Lines

These may lead to oscillation in certain circumstances because of inductance effects. This may be overcome by the addition of small resistors in series with each input lines at the amplifier end together with small shunt capacitors if the trouble is still evident.

4.6.3 Thermal e.m.f.'s

These are always a source of drift in d.c. amplifier applications and whenever symmetry is disturbed in the balanced input connection trouble can be expected.

4.6.4 Unsymmetrical Input Paths

These will always give rise to electromagnetic pick-up therefore balanced twin connecting lead should be used whenever possible, the screen being 'earthed' back to the signal earth connection provided on the amplifier.

4.7 SIGNAL/NOISE RATIO

There are some conditions (for example when driving the more sensitive fluid-damped galvanometers from the current output) when the amplifier current output swing is only a small fraction of the maximum possible. The amplifier noise performance is such that a good signal/noise ratio is obtained even under these conditions. However, an improvement can be achieved if required by inserting an attenuator between the voltage amplifier output and current amplifier input, so that the required maximum current now occurs at maximum output voltage. For example, if the maximum current swing required is ± 5 mA, a 10:1 attenuator would be used, consisting of a series 2·7 kohm from voltage amplifier output to current amplifier input, and 300 ohms from the latter to the common supply lead.

5 POWER UNIT M.1267

5.1 GENERAL CHARACTERISTICS

This unit contains two seperate 24 V stabilised power supplies both fitted with short circuit protection, and also incorporates a centre zero meter which may be switched to monitor up to six amplifier channels.

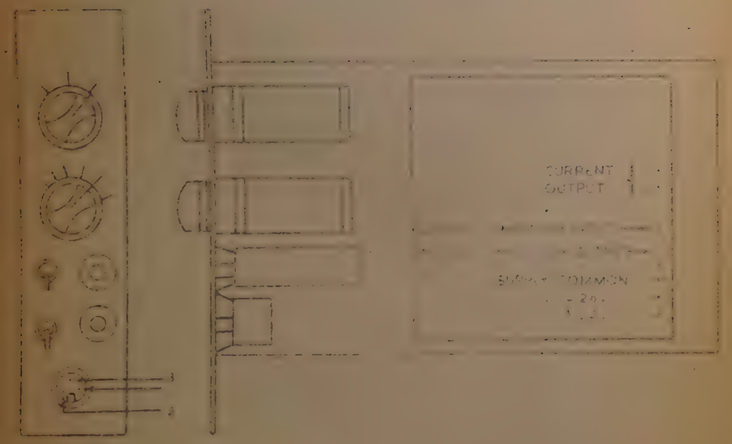
5.2 SPECIFICATION

Input	210 - 250 V 50 c/s.
Output	+ 24 V and - 24 V at 500 mA max.
Output impedance	Less than 0·1 ohm.
Ripple	2 mA on full load.
Overall Dimensions	Height 3"
	Width 4"
	Depth $9\frac{1}{2}$"
	Weight 7 lbs. 4 ozs.

6 NEST UNITS TYPES M.1852A - M.1855A

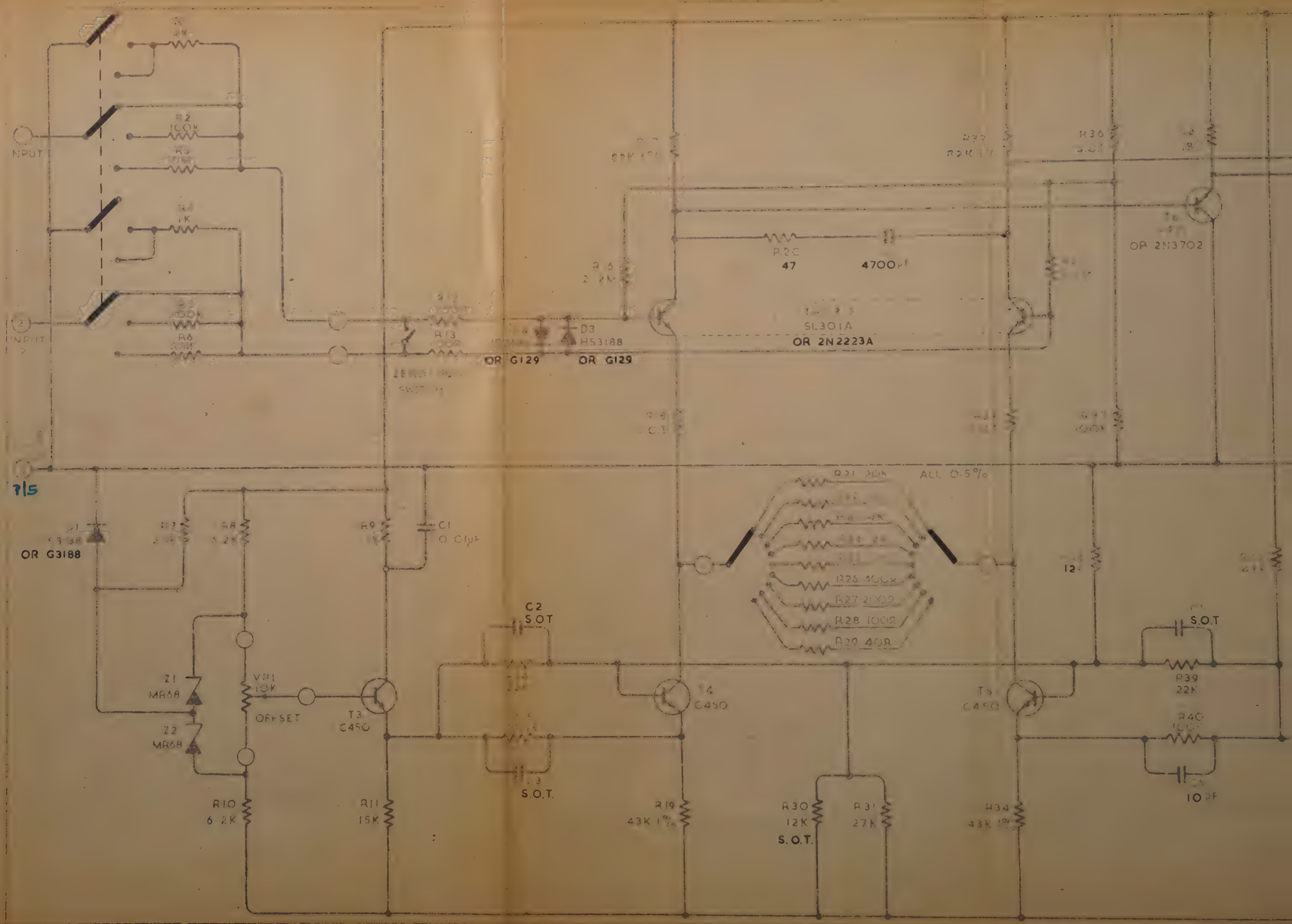
This series of nest units will accomodate one power supply unit and 2, 4 or 8 amplifier units, according to the type of nest unit. Bench and rack mounting units are available. Details of the wiring of all types of nest units are given on Drg. No. M.1854A/1.

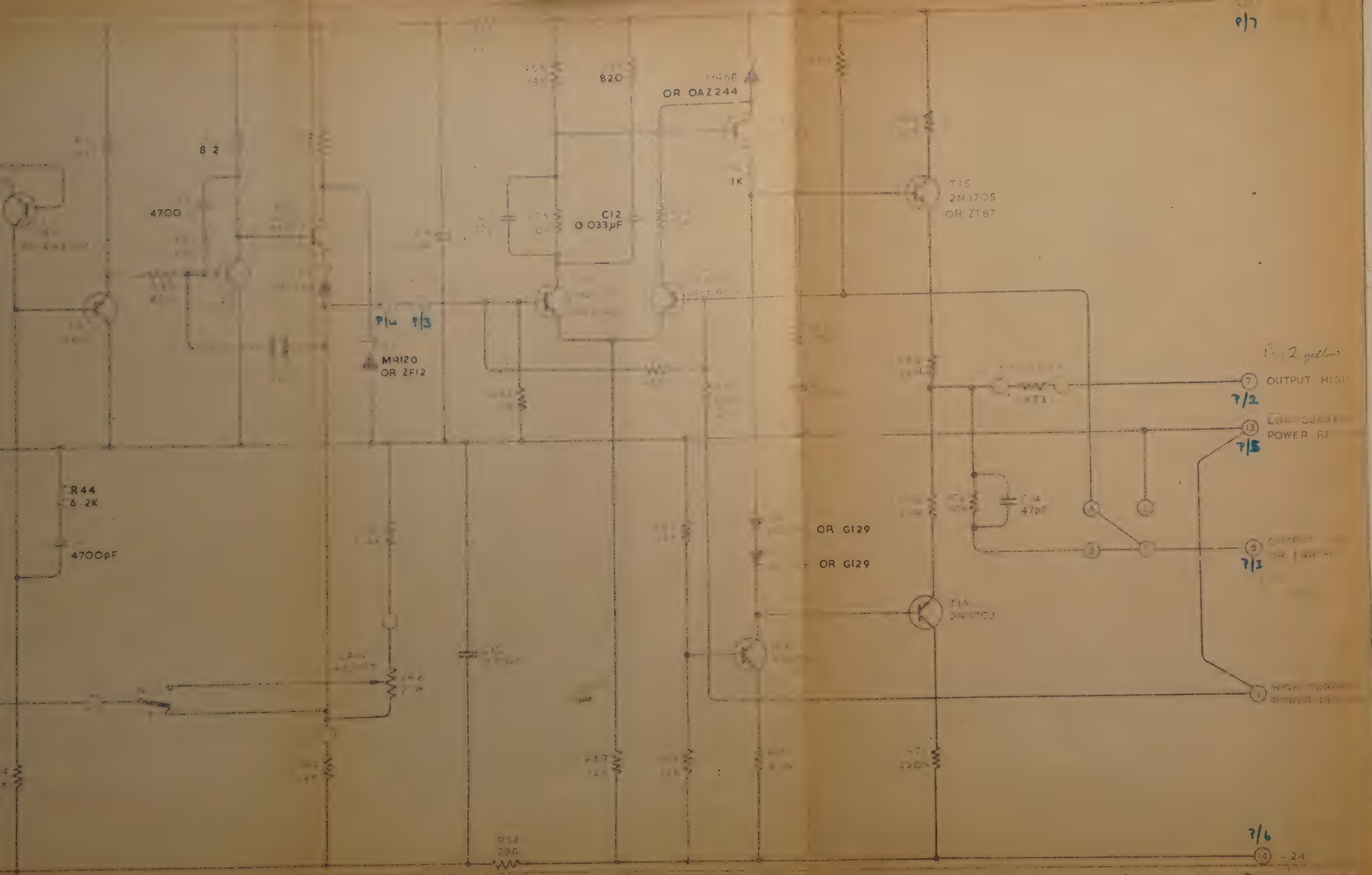
The Amplifiers are connected to the nest unit through a short flying lead terminated in a 9 way plug. To remove an amplifier from the nest unit, this plug should be disengaged, and the two front panel fixing screws removed. (On bench mounting units, the wrap-round cover must be removed to gain access to the plug).

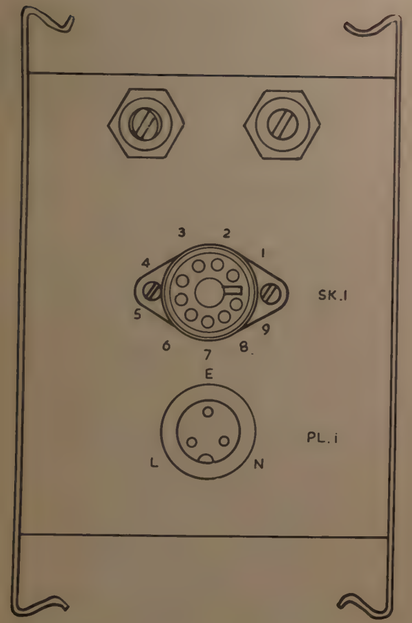


CONNECTIONS TO
INPUT PLUG SEEN
FROM REAR

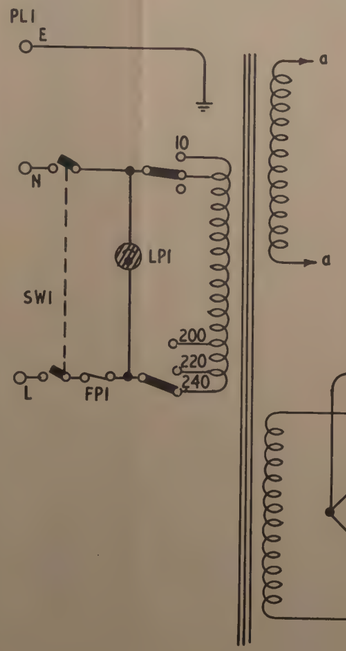
AMPLIFIER DESIGNED & MANUFACTURED BY
FYLDE ELECTRONIC LABORATORY LTD
(TYPE FE-[illegible])

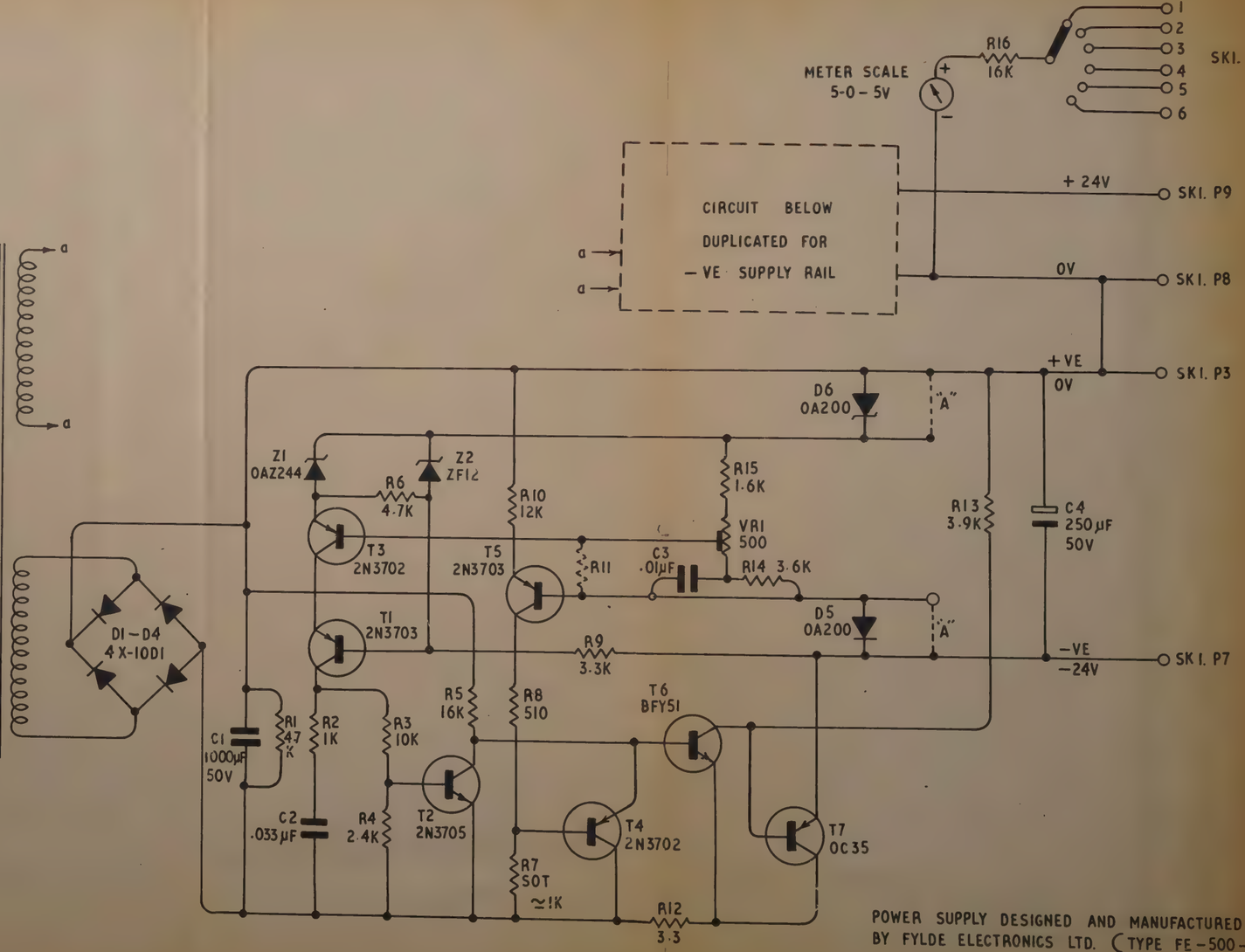



820
OR OAZ244
8 2
4700
1K
C12
0.033μF
P14 P13
M8120
OR ZF12
R44
6.2K
4700pF
OR G129
OR G129
R14
220
T15
2N3705
OR ZT87
P12 yellow
OUTPUT HIGH
P12
P15
P13
T14
2N3704
P16
- 24
D.C. AMPLIFIER (HIGH GAIN)



NOTE "A" :- D5, D6 OMITTED WHEN LINKS FITTED.





POWER SUPPLY DESIGNED AND MANUFACTURED BY FYLDE ELECTRONICS LTD. (TYPE FE-500-TP.)

No.	1	2	3	4	5						SOUTHERN INSTRUMENTS LTD. CAMBERLEY, SURREY, ENGLAND.		POWER SUPPLY (± 24V)	M1267/1

PLUG VIEWED
FROM REAR
PL2, PL3, PL5, etc.

SOCKET VIEWED
FROM REAR
SK3, SK5 etc.

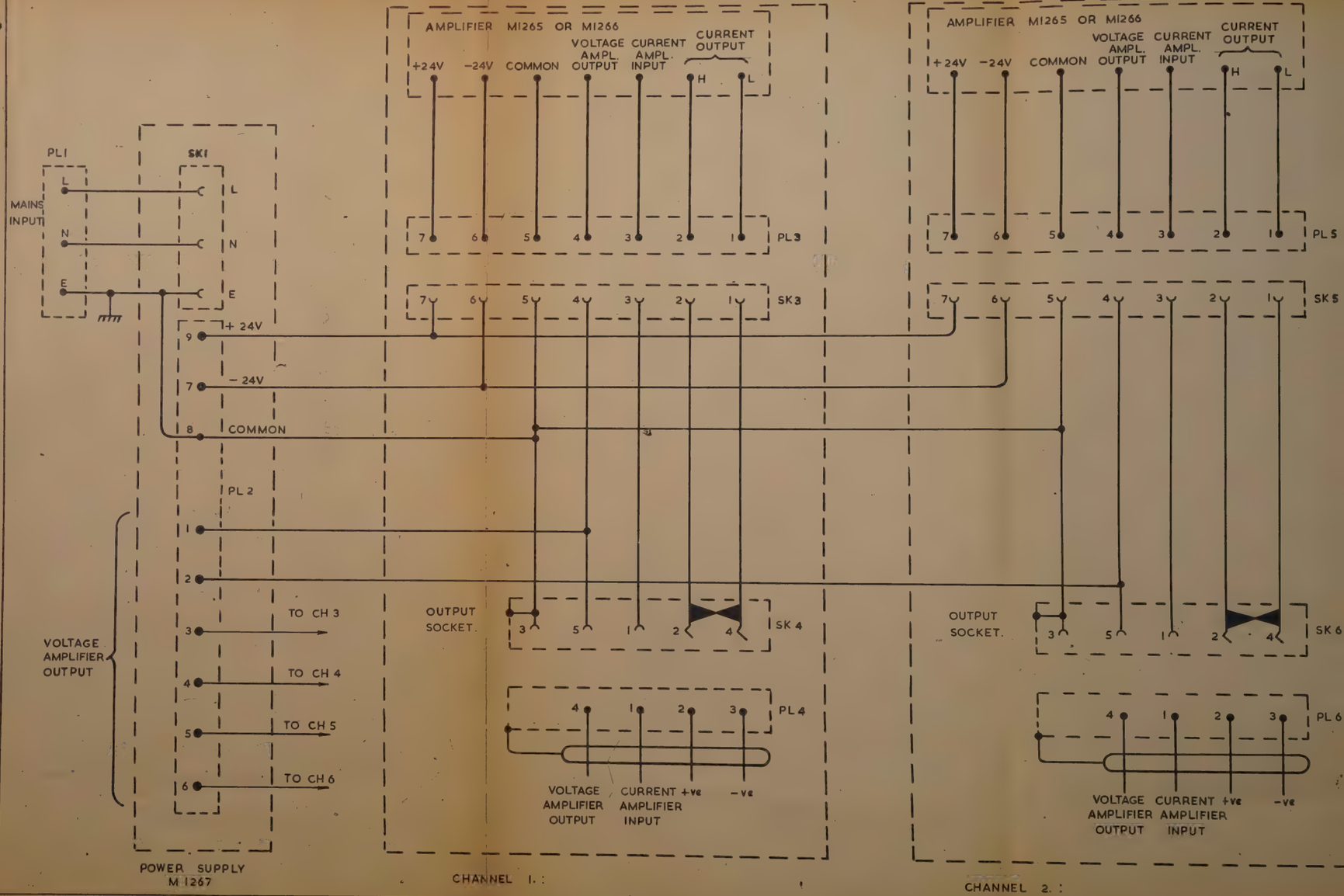
SOCKET VIEWED
FROM REAR

SK4, SK6 etc.

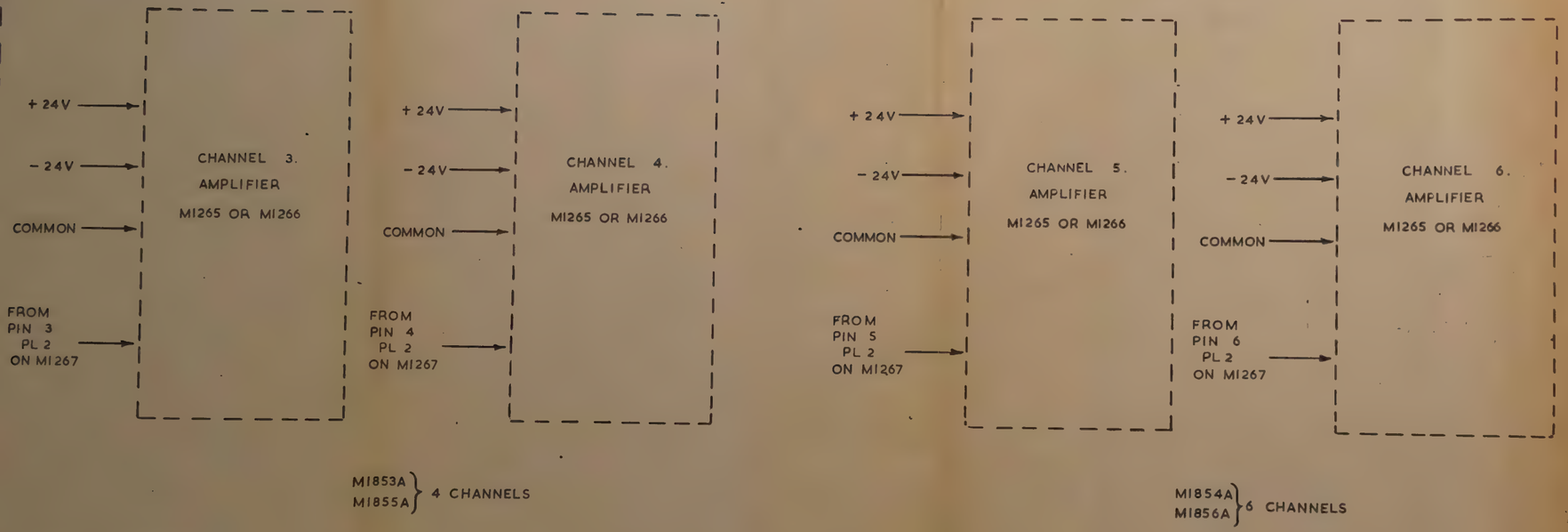
PL4, PL6 etc.

PLUG VIEWED
FROM REAR

NOTE : FOR CURRENT OUTPUT
LINK PINS 1 & 4
ON PL2, PL4 etc.
AND CONNECT LOAD
BETWEEN PINS 2 & 3.



No.	A	B	C	1							SOUTHERN INSTRUMENTS LTD. CAMBERLEY, SURREY, ENGLAND.



MI853A
MI855A } 4 CHANNELS

MI854A
MI856A } 6 CHANNELS

MI852A : 2 CHANNELS

D.C. AMPLIFIER NEST UNIT

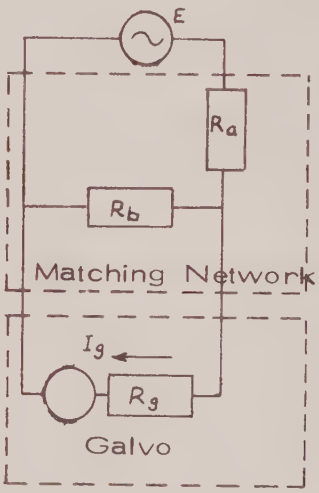
When using electromagnetically damped galvanometers, a resistive matching network is normally used. This network simultaneously reduces the input to the correct level and presents the correct matching resistance to the galvanometer.

The appropriate equations are as follows:-

$$R_a = \frac{E}{D} \cdot \frac{1}{K} \left\{ \frac{R_d}{R_d + R_g} \right\} = \frac{E}{D} \cdot K_1$$

$$R_b = \frac{R_a \cdot R_d}{R_a - R_d} \quad \text{where:-}$$

R_a = series matching resistance (k ohms)
R_b = parallel matching resistance (k ohms)
R_d = specified damping resistance for galvanometer (k ohms)
R_g = galvanometer resistance (kohms)
E = input voltage (volts)
I_g = required galvanometer current (mA)
D = required galvanometer deflection (cm)
K = galvanometer sensitivity (mA/cm)



The quantity $K_1 = \frac{1}{K} \left\{ \frac{R_d}{R_d + R_g} \right\}$ depends only on the galvanometer characteristics, so that a family of curves may be plotted relating R_a to D, for a fixed input voltage - say 1 volt. A family of these curves is plotted for galvanometers in the range manufactured by S.M.I. Ltd.

For voltages greater or less than 1 volt, R_a must be increased or decreased in direct proportion.

The value of R_b can be found from the extreme right-hand graph, once R_a is known.

EXAMPLE.

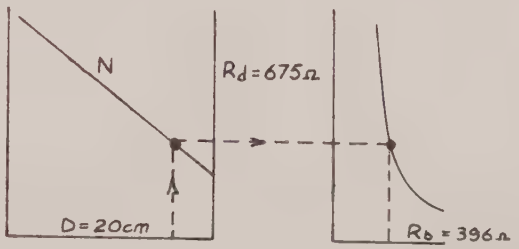
For 20cm deflection of a type N galvanometer, with 1 volt applied, we find:-

R_a = 675 ohm, R_b = 396 ohm.

For 5 volt applied,

R_a = 5 times 675
=3·3 kohm

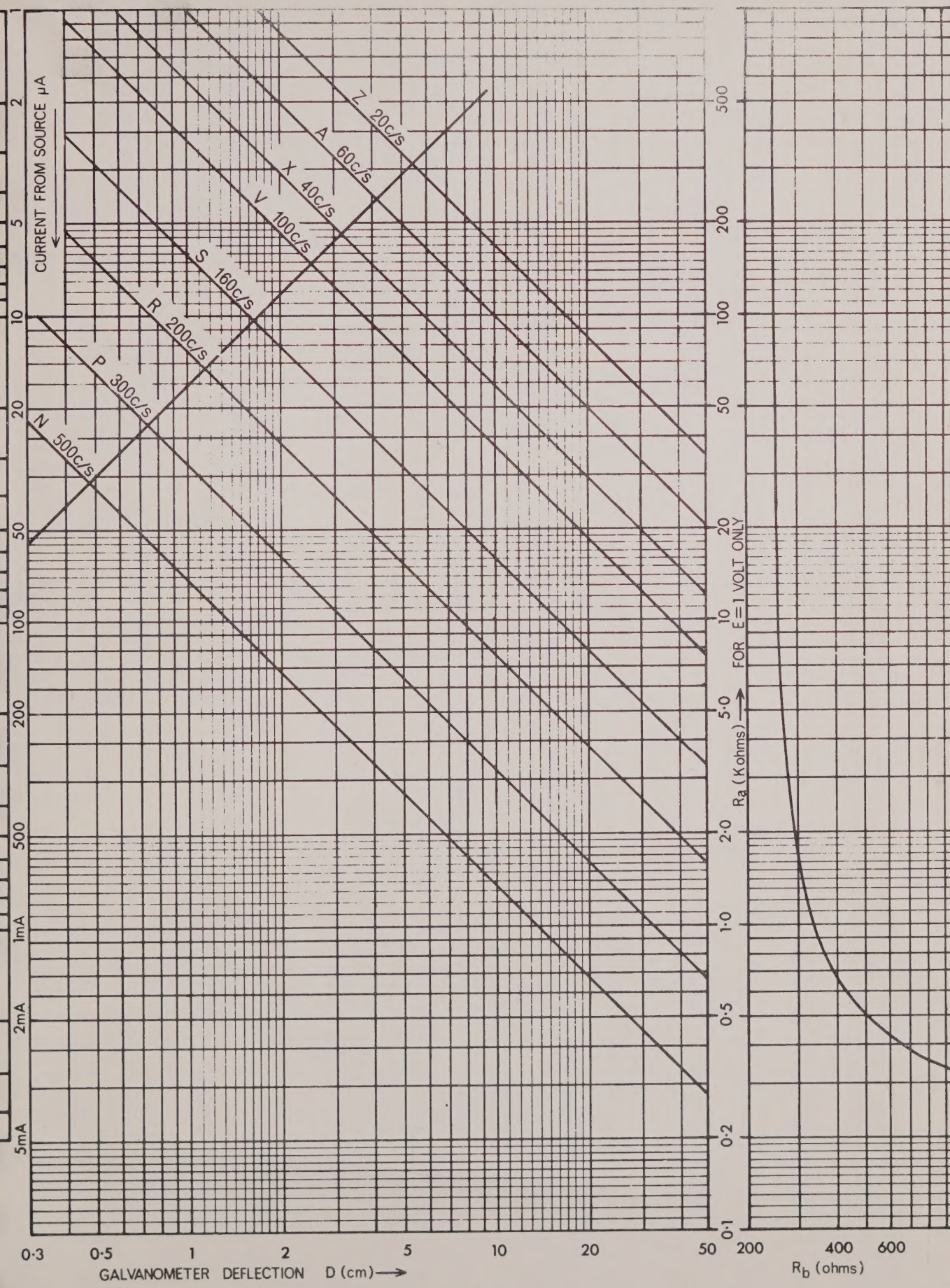
so R_b = 270 ohm



NOTES.

1. If the source of the input voltage E has a finite internal resistance then the value of R_a should be reduced by this amount.

2. The current drawn from the source for a given value of D can be found approximately from the scale on the left-handside. This assumes no voltage drop across the galvanometer, so the answer will be too large for values of R_a below about 1 kohm.



S.M.I. GALVANOMETER MATCHING NETWORKS

1300/341

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